

REVIEW



Nutrient density and bioaccessibility, and the antioxidant, satiety, glycemic, and alkalinizing potentials of fruit-based foods according to the degree of processing: a narrative review

Anthony Fardet^a  and Céline Richonnet^b

^aDepartment of Human Nutrition, Université Clermont Auvergne, INRA, UNH, Unité de Nutrition Humaine, CRNH Auvergne, Clermont-Ferrand, France; ^bDepartment of Nutrition, MOM Group, 1 Rue de la Pépinière, Paris, France

ABSTRACT

Epidemiological studies suggest that the protective effects of fruits against chronic diseases may vary according to their extent of processing. We therefore reviewed what the scientific literature states about the potential mechanisms underlying this “processing” effect by focusing on the most significant nutritional properties, namely, the nutritional density of bioactive compounds, the digestive bio-accessibility of nutrients, and the antioxidant, satietogenic, alkalizing and glycemic potentials. When possible, we have ranked fruits according to the international NOVA classification as un-/minimally processed, processed (mainly with added sugars), and ultra-processed fruits. Our literature review confirms that the more fruits are processed, the lower are their alkalizing, antioxidant and satietogenic potentials. For the glycemic index, the results are more difficult to interpret because fruits are a significant source of fructose with a very low glycemic index that “distorts” the “processing” effect. However, fruits in sirup tend to have a higher glycemic index, probably because of the highly bioavailable added sugars. Overall, the destructurement of the fruit fibrous matrix by thermal and mechanical treatments, combined with the addition of simple sugars, constitute the treatments that most degrade the fruit nutritive quality by diluting the nutritional density and attenuating the “matrix” effect. The new technological processes described as “nonthermal” (*e.g.*, pulsed electric fields, high pressures, supercritical CO₂, radiation, etc.) seem promising as they limit vitamin C and antioxidant phytonutrient losses in fruit while allowing satisfactory storage time. To preserve fruit longer, drying appears to be an interesting alternative to maintain the health potential of fruit, although it causes antioxidant losses. Finally, although “5 fruits and vegetables a day” is a well-known nutritional recommendation, in view of the results reviewed here, it would be relevant to be precise and include “preferably minimally processed”.

KEYWORDS

Fruits; processing; nutrient density; bio-accessibility; glycemic index; satiety potential; antioxidant capacity; alkalizing potential

Introduction

Fruit products are highly varied, ranging from the least processed (fresh and dried fruits) to the most processed (fruit juice with added sugars, fruit-based sodas, ultra-processed products containing fruit preparations such as filled or coated biscuits, dairy desserts, ice cream, etc.) with intermediate transformations (100% fruit juice, canned fruit, compote, jams, etc.). However, the impact on the health of fruit products according to processing has never been systematically studied except sparsely in observational or interventional studies in humans (Fardet, Richonnet, and Mazur 2019).

In a first study, on the basis of 10 pooled analyses and meta-analyses, we have shown that there may exist a gradient of the protective effect of fruits according to the degree of processing, *i.e.*, the least processed being the most protective (Fardet et al. 2019). This tendency might be in agreement with the international NOVA classification,

which ranks foods as un-/minimally processed, processed and ultra-processed, with ultra-processed products being the most deleterious for health (Monteiro et al. 2018). As previously demonstrated on 98 (Fardet 2016), 280 (Fardet et al. 2017) and 117 (Fardet, Lakhssassi, and Briffaz 2018) ready-to-eat products, the explanations behind this first global trend are probably at least three fold: 1) increased accessibility of sugars as the transformation deconstructs the matrix; 2) a low satiety potential due to a combined high sugar content and unstructured fruit matrices, generating further increased calorie intake; and 3) a deterioration of nutritional density in protective micro- and phytonutrients (“empty” calories). In addition, ultra-processed fruit drinks are richer in free sugars through added sweeteners (*e.g.*, sucrose, glucose and fructose), which might favor nonalcoholic fatty liver disease (Ouyang et al. 2008), insulin resistance (Bremer, Auinger, and Byrd 2009; Hochuli et al. 2012; McKeown et al. 2018), type 2 diabetes (Imamura et al. 2016;